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Research Article

Nurse Staffing and 30-day Readmission of Chronic Obstructive Pulmonary Disease Patients: A 10-year Retrospective Study of Patient Hospitalization

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SUMMARY

Purpose: Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity in many countries, and it has high rate of hospital readmissions due to recurrent exacerbations of the disease. Many previous studies have suggested further examination of the factors that contribute to hospital readmissions of COPD patients. However, evidence on the effects of nurse staffing by registered nurses (RNs) on the readmission of COPD patients is lacking in Korea. The aim of our study was to evaluate the effects of nurse staffing on hospital readmissions of COPD patients.

Methods: We used National Health Insurance claim data from 2002 to 2012. A total of 1,070 hospitals and 339,379 hospitalization cases were included in the analysis. We divided the number of RNs per 100 beds and the proportion of RNs on staff to one of three groups (Q1: low; Q2: moderate; Q3: high). A generalized estimating equation model was used to evaluate the associations between readmission and nurse staffing.

Results: A higher number of RNs was associated with lower readmission rates of 8.9% (Q2) and 7.9% (Q3) respectively. A similar effect was observed as the proportion of RNs among the total nursing staff gradually increased, resulting in lower readmission rates of 7.7% (Q2) and 8.3% (Q3).

Conclusions: Our results suggest notable positive effects of nurse staffing by RNs on patient outcomes. In addition, the magnitude of impact differed between different sizes of hospitals. Thus, human resource planning to solve staffing shortages should carefully consider the qualitative aspects of the nursing staff composition.

Introduction

Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality in many countries, and the societal burden of this disease has increased with the increasing prevalence of COPD and hospitalization [1,2]. Recurrent exacerbations of the disease were induced to such a high rate of readmission in COPD patient. One-fifth of COPD patients are readmitted within 30 days after discharge from the hospital [3]. Numerous factors that may be responsible for frequent COPD patient readmissions have been suggested. Earlier studies have suggested that related patient factors such as comorbidities, physical inactivity and smoking status were associated with an increased risk for readmission [4,5]. Other studies have suggested that hospital resources, including medical staffing, were associated with the readmission of COPD patients [6,7]. Since patient outcomes depend on the performance of those who deliver care, human resources are an important factor that cannot be ignored [8,9]. Nurse staffing is especially important because nursing

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demand is expanding to accommodate an aging population, so the demand for nurses is expected to continue its increase [10]. However, human resources are not always adequate to provide optimal patient care. There is a shortage of qualified human resources in many countries.

In Korea, nursing staff is classified as registered nurses (RNs) or certified nursing assistants (CNAs). The RNs are considered professional healthcare providers along with doctors, and are required to graduate from a university (4-year education program) or college (3-year education program) training program. In addition, they must pass a national RN licensing examination administered by the Ministry of Health and Welfare. The scope of performance for RNs in the Korean medical law included assisting doctors, and providing care to patients with injuries and sickness. In addition, RNs provide counseling with education to patients who needed nursing care, and health promotion activities to improve health status. CNAs are not classified as professional healthcare providers. The scope of performance for CNAs is based on enforcement of the Ministry of Health and Welfare in Korea, and they have the role of assistants for doctors and nurses. They are possible to providing the scope of performance of RN as a way of nursing assistant. CNAs are required to have a total of 1,520 hours of related education in an occupational high school or private educational institution, and pass a certification examination [11]. The role of CNAs in Korea is similar to that of licensed practical nurses in the United States [11,12]. However, CNAs in Korea do not have a license, and they have a certification for nursing assistant.

Although, nursing staff has increased gradually under the existing, specialized educational systems, the supply of nurses has not met the growing demand in Korea. Almost half of RNs were leaving their job within 3 years, due to dissatisfaction such as interpersonal relationship and working environment [13]. As a result, the high turnover rate of RNs induced a disparity between supply and demand. According to the Organisation for Economic Co-operation and Development (OECD) statistics for 2013, the number of nurses in Korea was lower than the average number of nurses on staff in other OECD countries, even when including CNAs (OECD: 9.1 nurses per 1,000 population; Korea: 5.1 per 1,000 population) [14]. Lower number of nursing staff imply an increased labor intensity and workload that results in lower quality care [15,16]. In addition, different staffing levels of RNs were also considered to be an important factor affecting patient outcomes [17]. Pioneers suggested that nursing staff levels were significantly associated with patient readmission rates and clinical outcomes [18,19]. In particular, high level of nurse staffing induced better outcome in clinical care for chronic diseases including COPD, chronic heart disease, and diabetes [19]. As chronic diseases needed long-term management for care, patient education and discharge planning during hospitalization was important for preventing unintended admission [20]. In addition, performance of such intervention was closely correlated with professional healthcare providers such as RNs. Thus, a low level of nurse staffing could possibly affect the risk of readmission in COPD patient. However, direct evidence on the influence of RN nursing staff on COPD patient outcomes is lacking in Korea. This information will aid the evaluation and improvement of human resource planning in hospitals.

The aim of our study was to evaluate the association between the level of nurse staffing and readmission rates of COPD patient. In particular, we considered the number of nurses and proportion of RNs separately to assess the exact effect of nurse staffing on patient outcome. In addition, we conducted subgroup analysis by type of hospital to evaluate different effects of nurse staffing on readmission of COPD patients.

Methods

Study design

We performed a secondary data analysis to examine the association between hospital nursing staff levels and patient readmission for COPD within 30 days. In addition, we did subgroup analysis by type of hospital to evaluate the effects of RN staff on the quality of care.

Setting and sample

We used claim data from National Health Insurance Services for the analysis. The database consisted of hospitalization data that included patient admissions from January 2002 to July 2012. We selected patients who were admitted for COPD as the major diagnosis (International Classification of Diseases, ICD-10: J44). A total of 1,070 hospitals and 339,379 hospitalization cases were included in our analysis. The unit of analysis was the hospitalization case.

Ethical considerations

We obtained approval from the Institutional Review Board (IRB) of the Graduate School of Public Health, Yonsei University (IRB no.: 2-1040939-AB-N-01-2016-218).

Measurement

The outcome variable in this study was readmission to the hospital within 30 days after discharge for COPD. We first identified the dates of the patient's first hospitalization and discharge in the calendar year. Next, we considered whether there was a readmission within 30 days after the discharge date. Readmission was defined as a new inpatient hospitalization within 1–30 days, of the first discharge date.

The number of active nursing staff was determined for the different hospitals, including the number of RNs per 100 beds and the proportion of RNs among the nursing staff. The proportion of RNs on staff was defined as the number of RNs/(number of RNs + number of CNAs). Based on the number of RNs per 100 beds and the proportion of RNs on staff, each institution was assigned to one of three groups according to quartiles where Q1 was low, Q2 was moderate, and Q3 was high. Q2 included that from the first quartile (median of the lower half, 25%) to the third quartile (median of the upper half, 75%).

We adjusted for the inpatient and hospital variables when analyzing the relationships between the number of RNs per 100 beds and the proportion of RNs, on the rates of readmission within 30 days after discharge. The patient variables included in the analysis were major diagnoses, age, sex, respiratory impairment grading [21], comorbidities, duration of oxygen therapy, length of stay (days), length of stay in an intensive care unit (ICU), type of health insurance, and hospitalization year (2002–2012). The patient's respiratory impairment grading was classified from grade 1 to grade 3, based on testing of forces expired volume in 1 second (FEV1) and arterial oxygen tension (PaO2). Grade 1 was defined as patients who had severe dyspnea requiring oxygen therapy and FEV1 $\leq$ 25.0% predicted or resting PaO2 $\leq$ 55 mmHg (room air). Grade 2 was defined as patients who had dyspnea when walking at home and FEV1 $\leq$ 30.0% predicted or resting PaO2 $\leq$ 60 mmHg (room air). Grade 3 was defined as patients who had dyspnea when walking at their own pace on level ground and FEV1 $\leq$ 40.0% predicted or resting PaO2 $\leq$ 65 mmHg (room air). Comorbidity was attributed to patients who had hypertension, diabetes, heart disease, or any other disease. The duration of oxygen therapy corresponded to the number of days that an inpatient received oxygen therapy during their hospitalization.

The hospital variables we considered included structural characteristics, the overall level of human resources in the hospital, and the COPD inpatient volume at each hospital. The structural characteristic variables included the type of institution, ownership status, teaching status and the number of beds. The human resource variables consisted of the number of RNs, doctors, and CNAs on staff.

Data collection

The data were collected during 2002–2012 and cases were selected for the documentation of a hospitalization due to COPD (ICD-10: J44). The cases of COPD outpatients or cases with missing data values were excluded. We only analyzed cases of patient hospitalization.

Data analysis

We examined the distribution of each categorical variable by examining frequencies and percentages and performed χ^2 tests to investigate the associations with patient readmissions within 30 days. We also performed an analysis of variance to compare the average values and standard deviations for the continuous variables. A generalized estimating equation was used to evaluate the associations between nursing staff levels and patient readmissions. Our model assumed proper distributions for each hospitalization case, while accounting for the correlation between cases within the same hospital. The correlation structure was modeled as an exchangeable correlation to determine the repeated outcome measurement of readmission. In addition, subgroup analyses were performed while also considering the type of hospital. All statistical analyses were performed using SAS statistical software version 9.3 (SAS Institute Inc., Cary, NC, USA). A $p < .05$ were considered indicative of a statistically significant difference.

Results

The data we used in this study consisted of 339,379 hospitalization cases and 1,070 hospitals. A total of 37,731 of the hospitalization cases (11.1%) resulted in a subsequent readmission within 30 days after the initial discharge. Considering the number of RNs per 100 beds, the rates of readmission were the highest in hospitals with reduced nurse staffing at level Q1, and the lowest in Q3, with higher nurse staffing levels (Q1: 10,771, > 12.9%; Q2: 18,999, > 11.2%; Q3: 7,961, > 9.3%). Similar results were also observed when considering the proportion of RNs among the total nursing staff. Q1 had highest readmission rates and Q3 had the lowest readmission rates. Considering the types of hospitals, 13.0% of hospital cases and 10.4% of general hospital cases were readmitted within 30 days (Table 1).

We used generalized estimating equation models to evaluate the relationships between cases of readmission within 30 days after discharge and the explanatory variables. A higher number of RNs per 100 beds and a higher proportion of RNs on staff were significantly associated with a lower odds ratio (OR) of readmission, when compared with a lower level of nurse staffing (Q1). Reviewing the different numbers of RNs per 100 beds, a higher number of RNs was associated with lower readmission rates of 8.9% (Q2) and 7.9% (Q3) respectively (Q2: OR = 0.91, $p < .001$; Q3: OR = 0.93, $p = .029$). Similarly, considering the proportion of RNs on staff, a high number of RNs among the total nursing staff was associated with lower readmission rates for COPD patients. The size of this effect gradually increased with a higher level of RNs among total nurse staffing, so that readmission rates were observed to be 7.7% (Q2) and 8.3% (Q3), respectively (Q2: OR = 0.92, $p = .002$; Q3: OR = 0.92, $p = .003$). In contrast, a higher number of doctors per 100 beds showed a negative effect on readmissions, as the number of doctors increased. However, the size of this effect was not large (0.4% increase) (Table 2).

We performed subgroup analyses by the type of hospital. The results for the types of hospitals indicated that a low OR of readmission within 30 days was associated with higher nursing staff levels in both hospitals and general hospitals. Because, there was different function and size between hospital and general hospital: the size of hospital is smaller than that of a general hospital, and provided care to patient with relatively not severe. Furthermore, general hospital included tertiary hospital that was classified to advanced general hospital, these may affect our outcome variable.

Table 1 *General Characteristics of Hospital and Patients.*

Variable	Readmission ($N = 339,379$)		χ^2/F	p
	Yes *n* (%) or *Mean ± SD*	No *n* (%) or *Mean ± SD*		
Hospital characteristics ($n = 1,070$)				
No. of RNs per 100 beds				
Q1	10,771 (12.9)	72,787 (87.1)	553.13	< .001
Q2	18,999 (11.2)	151,198 (88.8)		
Q3	7,961 (9.3)	77,663 (90.7)		
Proportion of RNs				
Q1	10,951 (13.0)	73,392 (87.0)	453.34	< .001
Q2	18,426 (10.8)	151,636 (89.2)		
Q3	8,354 (9.8)	76,620 (90.2)		
No. of doctors per 100 beds	16.26 ± 15.35	18.49 ± 16.25	641.40	< .001
No. of beds	425.86 ± 375.56	469.80 ± 388.95	431.13	< .001
Patients volume per hospital	144.56 ± 105.49	139.02 ± 105.08	93.03	< .001
Type of hospital				
General hospital ($n = 316$)	25,786 (10.4)	221,647 (89.6)	447.78	< .001
Hospital ($n = 754$)	11,945 (13.0)	80,001 (87.0)		
Ownership				
Public ($n = 39$)	4,769 (13.4)	30,765 (86.6)	212.82	< .001
Private ($n = 1,031$)	32,962 (10.9)	270,883 (89.2)		
Teaching				
Teaching ($n = 151$)	14,791 (9.5)	141,016 (90.5)	768.96	< .001
Nonteaching ($n = 919$)	22,940 (12.5)	160,632 (87.5)		
Patient characteristics				
Sex				
Male	29,410 (12.4)	208,690 (87.7)	1,229.66	< .001
Female	8,321 (8.2)	92,958 (91.8)		
Age (yr)	71.49 ± 11.12	71.55 ± 11.64	1.02	.313
Respiratory impairment grading				
1 (FEV1 ≤ 25.0% or PaO2 ≤ 55 mmHg)	2,636 (17.7)	12,283 (82.3)	1,683.95	< .001
2 (FEV1 ≤ 30.0% or PaO2 ≤ 60 mmHg)	2,461 (17.0)	12,042 (83.0)		
3 (FEV1 ≤ 40.0% or PaO2 ≤ 65 mmHg)	2,477 (15.5)	13,480 (84.5)		
None	30,157 (10.3)	263,843 (89.7)		
Comorbidities				
Hypertension or diabetes	1,944 (11.8)	14,556 (88.2)	79.31	< .001
Heart disease	487 (15.8)	2,589 (84.2)		
Other	34,833 (11.0)	280,891 (89.0)		
None	467 (11.5)	3,612 (88.6)		
Duration of oxygen therapy (d)	0.35 ± 2.67	0.53 ± 3.48	90.70	< .001
Length of stay (d)	14.01 ± 11.52	12.35 ± 11.23	730.50	< .001
Length of stay in ICU (d)	0.35 ± 2.46	0.53 ± 3.36	103.55	< .001
Type of insurance coverage				
Medical Aid	25,894 (10.0)	234,183 (90.0)	1,518.72	< .001
National Health Insurance	11,837 (14.9)	67,465 (85.1)		
Total	37,731 (11.1)	301,648 (88.9)		

Note. FEV1 = forced expired volume in one second; ICU = intensive care unit; PaO2 = arterial oxygen tension; RN = registered nurse.
Note: Adjusted for year.

In hospitals, a higher proportion of RNs was significantly associated with a lower readmission rate, with 9.6% (Q2) and 22.6% (Q3) of reduction observed, compared with Q1 (Q2: OR = 0.90, $p = .013$; Q3: OR = 0.77, $p < .001$). In general hospitals, an increased number of RNs per 100 beds was significantly associated with a lower readmission rate, with 13.0% (Q2) and 11.3% (Q3) of reduction observed, compared with Q1 (Q2: OR = 0.87, $p < .001$; Q3: OR = 0.89, $p = .005$) (Table 3).

Discussion

The aim of our study was to evaluate the associations between RN nursing staff levels and COPD patient readmission within 30 days of discharge. In our study, the number of RNs per 100 beds and the proportion of RNs on staff were significantly associated with a patient's readmission for COPD.

Based on the number of doctors per 100 beds, our study observed no positive effects on readmission rates related to having more doctors on staff. A possible explanation might be associated with specific physician-related factors. COPD patients may require specialized care related to the severity of their disease, and pulmonology specialist physicians are important for achieving satisfactory outcomes in COPD patient care [7,22]. The number of doctors in our data set included specialist physicians as well as general physicians and the variable effects of different physician specialties may not be reflected in our results, due to the limitations of our data. Considering the number of RNs per 100 beds, a higher level of RNs per 100 beds was associated with a lower OR of readmission; however, the size of this effect was not consistently larger with higher numbers of RNs per 100 beds. When reviewing the proportion of RNs on the nursing staff, the positive effect of more RNs consistently increased with a higher proportion of RNs. Thus, we considered this result carefully regarding two aspects including plausible reasons and meanings. First, a plausible explanation about our result might come from considering the elevated level of patient care education and skill contributed by RNs [17]. RNs are trained to a high level of education and practical skills, and are considered a skilled professional human resource. Different proportions of nurse staffing between RNs and CNAs should affect patient outcomes. Consequently, an increased number of RNs per 100 beds was associated with better outcomes on a quantitative basis. In addition, a high proportion of RNs among the total nursing staff was instrumental to achieving improvements in the quality of care, on a qualitative basis in our study. Second, we consider our results carefully compared with the level of official nurse staffing in Korea. According to medical law, overall nurse-to-patient ratio in hospital was recommended as legal standards for nurse staffing (one nurse per 2.5 annual average inpatient). In a separate medical law, incentive system for hospital was established in 1999 which reimbursed a hospital based on the average ratio of beds to nurses [23]. The level of nurse staffing was classified to seven groups (tertiary hospital: grade 6; general hospital and hospital: grade 7) based on the beds per nurse staffing. The classification included grade 1 (< nurse per 2.5 beds) to grade 5 (nurse per 4.0–4.4 beds) in case of general hospital and hospital, and they received incentive under the reimbursement system. No incentive was given to a hospital classified to baseline of grade 6 (nurse per 4.5–5.9 beds). Hospitals classified to grade 7 (≥ nurse per 6.0 beds) received a penalty, meaning that they were reimbursed less. However, many hospitals did not fulfill the recommended staffing level [23]. In addition, official recommendation for nurse staffing considered only quantitative aspects such as nurse-to-beds ratio, but did not reflect the actual skill contribution in each hospital. In

Table 2 *Results of Generalized Estimating Equation Model on 30-day Readmission.*

Variables	OR	95% CI		p
No. of RNs per 100 beds				
Q1 (low)	1.00	–	–	
Q2 (moderate)	0.91	0.87	0.96	< .001
Q3 (high)	0.93	0.87	0.99	.029
Proportion of RN				
Q1 (low)	1.00	–	–	
Q2 (moderate)	0.92	0.88	0.90	.002
Q3 (high)	0.92	0.87	0.90	.003
No. of doctors per 100 beds	1.00	1.00	1.01	< .001
No. of 100 beds	1.00	0.99	1.00	.169
Patients volume per hospital	1.00	1.00	1.00	< .001
Type of hospital				
Hospital	1.15	1.10	1.21	< .001
General hospital	1.00	–	–	
Ownership				
Public	1.14	1.09	1.20	< .001
Private	1.00	–	–	
Teaching				
Teaching	0.84	0.80	0.88	< .001
Nonteaching	1.00	–	–	
Sex				
Male	1.69	1.63	1.75	< .001
Female	1.00	–	–	
Age	1.01	1.01	1.01	< .001
Respiratory impairment grading				
1 (FEV1 ≤ 25.0% or PaO2 ≤ 55 mmHg)	1.87	1.69	2.06	< .001
2 (FEV1 ≤ 30.0% or PaO2 ≤ 60 mmHg)	1.83	1.67	2.00	< .001
3 (FEV1 ≤ 40.0% or PaO2 ≤ 65 mmHg)	1.53	1.40	1.68	< .001
None	1.00	–	–	
Comorbidities				
Hypertension or diabetes	1.02	0.83	1.25	.867
Heart disease	1.23	0.93	1.61	.140
Other	0.98	0.81	1.18	.800
None	1.00	–	–	
Length of oxygen therapy (d)	0.99	0.98	1.00	.006
Length of stay (d)	1.01	1.01	1.02	< .001
Length of stay in ICU (d)	1.00	0.99	1.00	.315
Type of insurance coverage				
Medical Aid	1.38	1.32	1.44	< .001
National Health Insurance	1.00	–	–	

Note. CI = confidence interval; ICU = intensive care unit; OR = odds ratio; RN = registered nurse.
Note: Adjusted for year.

Table 3 *Subgroup Analysis of Readmission Within 30 days After Discharge by Type of Hospital.*

Variables	OR	95% CI		p
Hospital				
No. of RN per 100 beds				
Q1 (low)	1.00	–	–	
Q2 (moderate)	0.94	0.87	1.03	.165
Q3 (high)	0.76	0.48	1.21	.244
Proportion of RN				
Q1 (low)	1.00	–	–	
Q2 (moderate)	0.90	0.83	0.98	.013
Q3 (high)	0.77	0.68	0.88	< .001
General hospital				
No. of RN per 100 beds				
Q1 (low)	1.00	–	–	
Q2 (moderate)	0.87	0.81	0.94	< .001
Q3 (high)	0.89	0.82	0.96	.005
Proportion of RN				
Q1 (low)	1.00	–	–	
Q2 (moderate)	0.96	0.90	1.04	.324
Q3 (high)	0.97	0.90	1.05	.482

Note. CI = confidence interval; OR = odds ratio; RN = registered nurse.
Note: Adjusted for number of doctors per 100 beds, number of beds, patient volume per hospital, ownership status, teaching, sex, age, respiratory impairment grading, comorbidity, length of oxygen therapy, length of stay, length of intensive care unit, type of insurance coverage and year.

our study, a moderate level of RNs (73.5%–89.7%) and a high level of RNs (≥ 89.8%) were positively associated with a low risk of readmission. Our result implies that the standard for nurse staffing have to reflect actual distribution of skillful nurse staffing in each hospital. Evaluation for distribution of RNs induced more realistic and effective management for nurse staffing, and this would be bring improvement in patient outcome. Our findings are similar to those of previous studies that found that a high level of nursing staff was associated with a lower risk of readmission [24,25]. However, because a proportional beneficial outcome effect was observed only with a higher proportion of RNs on staff, we sought to consider other hospital characteristics that might influence the magnitude of the observed effects and conducted a further analysis by the type of hospital.

The results of our subgroup analysis by the type of hospital showed that a higher staffing level of RNs was associated with a lower readmission rate in hospitals. However, only a higher proportion of RNs among the total nursing staff consistently showed significantly positive effects on readmission rates. In the case of general hospitals, an increased number of RNs per 100 beds was significantly associated with a lower OR of readmission. A plausible explanation might be related to the size of the hospital. The criteria for the classification of hospitals in Korea are based on the number of beds, the available medical service departments, functions, and certain certifications based on medical law [26]. General hospitals can provide a higher level of care for patients and must be of a certain minimal size, with specialists in each medical service department. Although these general hospitals already possess a high level of nurse staffing by RNs, a quantitative expansion by increasing the number of RNs should affect patient outcomes. Alternatively, hospitals are smaller than the general hospitals, and provide care for less complicated patients. The smaller hospitals preferred to hire CNAs rather than RNs to control costs [27]. The effects of an expanded RN nursing staff on patient outcomes would be larger here, because more of the nursing staff in hospitals is composed of CNAs. In addition, only in hospitals, a higher level of nursing staff was observed to consistently result in a larger outcome benefit. This observation may be the result of the hospital patients having a less severe disease than those patients in the larger general hospitals. General hospitals can offer a higher level of care for patients and provide care for a larger proportion of seriously ill patients than small hospitals do. In these larger institutions, there may be a limited potential to improve patient outcomes by increasing their already high proportion of RNs on staff. Other specialized human resource strategies will be important to achieving improved quality of care in these larger hospitals.

In Korea, workforce planning for nurse staffing was announced in 2013 to address the issues related to the shortage of nursing staff. Under this plan, nursing staff were categorized into three grades, with the possibility of changing their grade after passing the test. This new strategy was proposed as a solution to the nurse shortage, while achieving cost savings. However, it has been controversial to both policymakers and others concerned with the impact on the quality of care [28,29]. Low levels of nursing staff are associated with a lower quality of care, and adverse events always incur additional costs. The cost of hiring RNs is greater than CNAs, but these higher costs would be offset by the savings associated with a reduction in the number of readmissions and overall improvements in the quality of care. Our results have provided evidence to policymakers that a high level of nurse staffing by RNs is important to the quality of care. In addition, the effects of nurse staffing by RNs are different, depending on the type of hospital. Thus, workforce planning aimed at solving the shortage of human resources must carefully consider the advantages and qualitative aspects of employing higher skilled RNs as well as the size of the hospital.

Our study has several limitations. First, since we only used claim data, we could not measure other patient characteristics that could have affected readmission rates, such as patients' education, socioeconomic status, clinical severity, and their current medical treatment. Similarly, we were unable to evaluate effects of specialist physicians on patient outcomes, due to the granularity limitations of our data. Future studies should consider the contributions of specialist physicians and the associated effects on patient outcomes. Secondly, we could not consider the patient's overall health service utilization data, such as the number of outpatient visits and other admissions into different hospital types, because of the limitations of our data. Thus, the effects of the nursing staff on readmission rates for COPD patients may be different in other types of hospitals. Finally, we could not consider human resources changes within the hospitals, such as turnover rates or resignations from the nursing staff.

Despite these limitations, our study has several strengths. First, the National Health Insurance claim data used in our study includes a large number of cases and hospitals, collected over a long period. The results of our study provided important evidence of the benefits of nurse staffing by RNs, and meaningful insight to policymakers involved in workforce planning. Secondly, our results suggest that the qualitative aspects of nurse staffing by RNs are important to improving patient outcomes. Many previous studies have suggested that nurse staffing was important to improving the quality of care, however, specific information about the relationship between the numbers and proportion of RNs on the nursing staff and readmission rates for COPD patients was lacking in Korea. Finally, our results suggested some important factors that policymakers should consider in future human resource planning.

Conclusion

Our results suggest the positive effects of nurse staffing by RNs on COPD patient outcomes. A high number of RNs was associated with lower patient readmission rates within 30 days of discharge, and different effects of RN staffing on patient care were observed depending on the type of hospital. Thus, policymakers should carefully consider workforce planning as a means to address the shortage of qualified nursing staff while improving the overall quality of care.

Conflicts of interest

There is no conflict of interest to declare.

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